AIR AND GAS COMPRESSORS

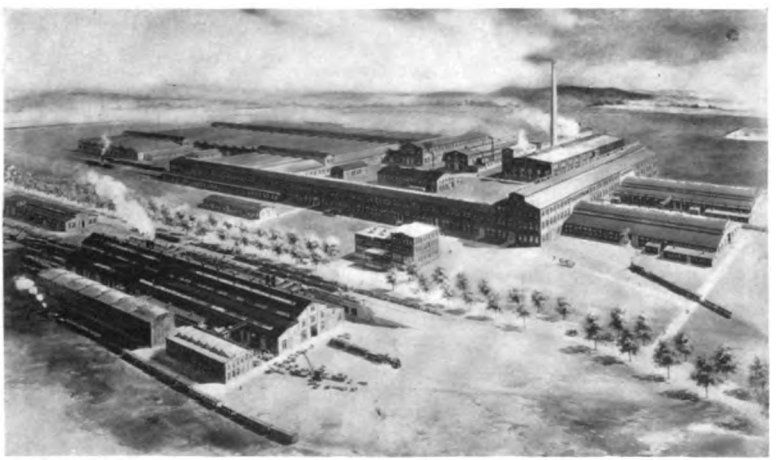
INGERSOLL-RAND COMPANY
11 BROADWAY, NEW YORK
Form No. 3001 April, 1909

THE cost of compressed air involves three factors: first, the interest and depreciation on the plant investment; second, the operating cost; third, the maintenance or up-keep cost. All three of these depend upon the design and construction of the air compressor. A cheap machine may lower the first element of cost, but it will increase the other two elements. Good business, therefore, recommends the installation of a first-class machine at a fair cost, which will thereafter demand the minimum charge for operation and maintenance.

A Historical Sketch

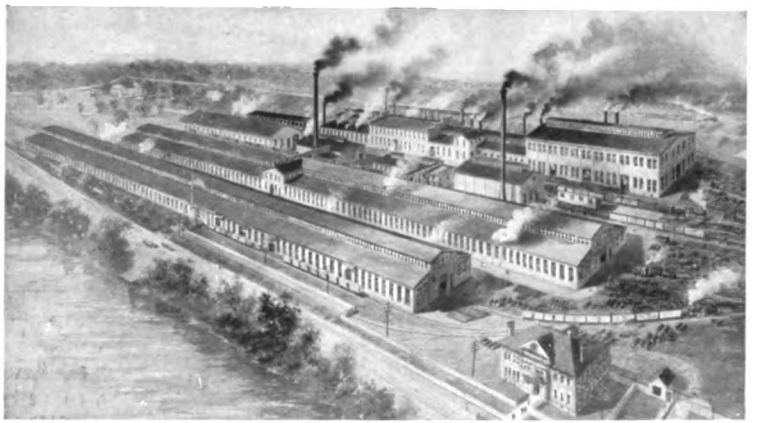
For thirty-eight years (1909) the Ingersoll-Rand Company, or its constituent concerns, has directed its efforts toward the problem of compressor economy. The present Company is a union of the Ingersoll-Sergeant Drill Company and the Rand Drill Company.

The former concern dates back to 1871 and includes the Sergeant and Cullingworth Company and the Ingersoll Rock Drill Company.



Plant of the Ingersoll-Rand Co., at Phillipsburg, N. J.

Digitized by Google



Plant of the Ingersoll-Rand Co., at Easton, Pa.

The Rand Drill Company was started in 1871 as the Rand and Waring Drill and Compressor Company, later changed to the Rand Drill Company, incorporated in 1879.

Manufacturing Facilities and Output

Starting with the original small shops of the old Rand and Ingersoll Companies, in New York City, the growth of the business has necessitated the present large shops of the Ingersoll-Rand Company, located at Painted Post, New York, at Easton, Pa., at Phillipsburg, New Jersey, and at Athens, Pa. These works give employment to about 3500 men and, in combination,



Plant of Ingersoll-Rand Co., at Painted Post, N. Y.

Digitized by Google

they represent the largest, most complete and most highly organized shops for the building of air power machinery in the world.

The Phillipsburg Shops alone are the largest of the kind in the world; and the Company's total output to date (1909) is approximately as follows:

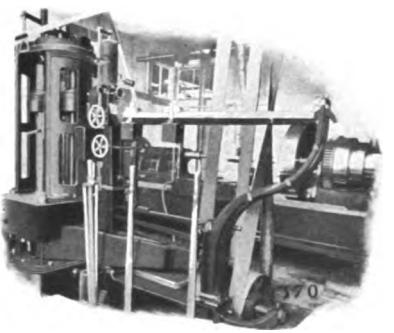
Air and Gas Compressors	850,000 H. P.
Rock Drills	100,000
Coal Cutters	6,000
Stone Channelers	600

Designs

The history of the Company, dating back to the beginning of pneumatic practise, is the history of the development of compressed air as a power; and the Company's engineers have originated the compressor types which find general acceptance to-day. More than a generation of specialized experience, therefore, is embodied in Ingersoll-Rand Compressors as at present built, commanding the confidence of the buying public in these machines as representing the most sound practise and the most advanced ideas.

Materials

The raw materials from which Ingersoll-Rand Compressors are built are the best that the market affords. Many of them are specially made to meet the Company's specifications. Composition metals are made from formulas covering a vast experience and observation. Cast iron is of a particular grade to meet the demand for a close, uniform, homogeneous structure, fine wearing qualities and the maximum strength. The steels used contain varying percentages of carbon for various purposes, the degree of carbonization representing the best judgment of experts for the particular service in question. Alloy steels are also used where the circumstances indicate that they are best for the purpose. All materials are rigidly tested before acceptance and must conform with the strict letter and spirit of the specifications.



A Testing Machine in the Materials Testing Department

Oil Treatment of Steel

An oil-treating process is used for all steel parts requiring unusual staying power; this process, very similar to that used by the United

Digitized by Google



The Oil Treating Department, Showing Oil Tanks and Annealing Furnaces

States Government on ordnance forgings, being the result of years of experiment. The steel, after rough machining, is heated to a high temperature and plunged in an oil bath where it remains until cool. The exact temperature used is determined by the results sought. From the oil bath the parts go to the annealing ovens, where all unbalanced stresses of cooling, straightening or forging are relieved. One result of this treatment is an increase of 25 to 30 per cent. in the tensile strength of the steel, meaning an equivalent addition to its "life" of usefulness. Other results are an increase in the elastic limit, in the ductility, and in the toughness of the steel.

Manufacturing Methods

Dimensional uniformity is one of the fundamental requisites of parts of Ingersoll-Rand Compressors. A uniform quality and



A Typical Group of Compressors in the Easton Shops, Showing the System of Building in Quantities

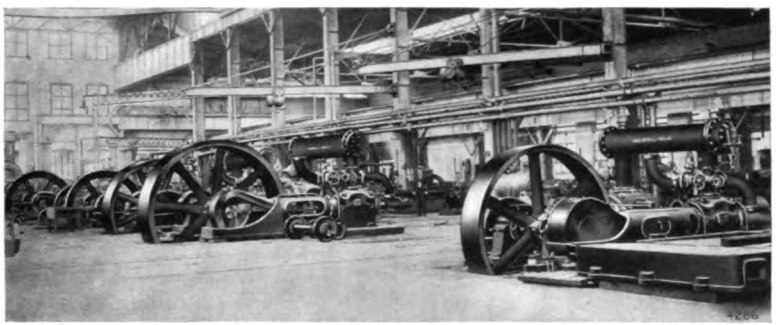
character of work is also sought. To this end the most advanced types of machine tools are used in the shops, automatic in operation so far as may be. Special tools have been built at great cost

Digitized by Google

for the manufacture of special parts in quantity. Expert supervision is over every detail of production. Skilled workmen only are employed, working under a system whereby it is to the interest of each to improve his product and better the character of his work. Machines are rarely built singly, but are put through the shops in lots of six, ten or twenty, as the case may be.

Interchangeability

Each part of an Ingersoll-Rand Compressor is separately inspected and measured by "limit gages" before acceptance for stock. All wearing parts, subject to replacement, must conform with the most exacting standards as to dimensional correctness This system of limit gage test enables the Company to maintain interchangeability of wearing parts, so that when repair parts are ordered, it will be with the assurance that they will fit in place correctly.



The Erecting Floor and Test Pits in the Phillipsburg Shops, with large Compressors being Erected and under Test and Inspection

Tests and Inspection

Aside from this test of individual parts, each machine during its assembling is inspected at every stage. The completed compressor then goes to the testing pit, where it is given a long test run at normal rated conditions, followed by another test at overload and higher speed. Indicator cards are repeatedly taken from all but the smallest stock machines, and these cards are made a part of the shop record of that machine. All adjustments are made on all machines for the best operating results. There can be no uncertainty as to the performance of an Ingersoll-Rand Compressor. It makes its record before it is shipped and when it leaves the shops it is known to be *right*. It goes out to work backed by the Company's prestige and guarantees.

Compressor Types

In pages following, the standard types of Ingersoll-Rand Compressors are illustrated and briefly described. It will be

Digitized by Google

noted that the line includes machines for low, moderate, high and very high pressure; steam and power driven, straight line and duplex, vertical and horizontal types; single, two, three and four stage compression; capacities from the very smallest to the largest standard listed size. Every possible demand can thus be met by some machine in this line; and from the "Baby" to the largest Corliss compressor, only one grade and quality is offered—the very best. The remarks in this pamphlet are applicable to every type and size built by the Company. Separate pamphlets, as listed in the sections following, give more complete descriptions of each type; and the specifications go into minute details of construction.

Air Valve Movements

The air valves used on various Ingersoll-Rand Compressor types are among the most prominent distinguishing features of these machines. Nothing will lower the economy of a compressor more quickly than defects or shortcomings in its air valves. The Company has therefore made a most careful study of these parts during its thirty-eight years of compressor building; and out of the multitude of different valve types invented, developed and tested, the following remain as representing all that is best in valve design and construction.



A Single "Hurricane-Inlet" Valve

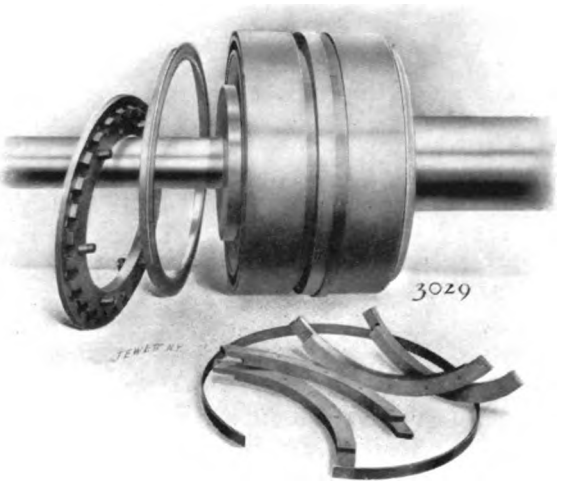
The "Hurricane-Inlet" Valve

The "Hurricane-Inlet" Valve, standard on most of the Ingersoll types of Ingersoll-Rand Compressors, is a development of the original Piston Inlet Valve. It retains the "piston air inlet tube" feature of the latter, but differs in some very important details, resulting in a marked improvement. Each valve—one on each piston face—is a continuous ring of high-carbon, oil treated steel, forged without welds and turned to a light "T" section with no holes, slots or weak places. The port is an annular opening in the piston face, of unusual area and with no obstructions whatever. The bar of the "T" is the valve face seating over the port. The upright of the "T" is the guide section sliding on a steel guide plate bolted to the piston face and made with openings so that the valve is double-ported.

The valves travel with the piston, the one in front closing first by its inertia and remaining closed under air pressure. The valve behind, as soon as the piston starts, drops back against its stop, making a full opening maintained until the piston stops, when the valve slides gently to its seat. The inlet valve cannot open until the clearance air is expanded to atmosphere, so there can be no escape of air already compressed. The valve being

Digitized by Google

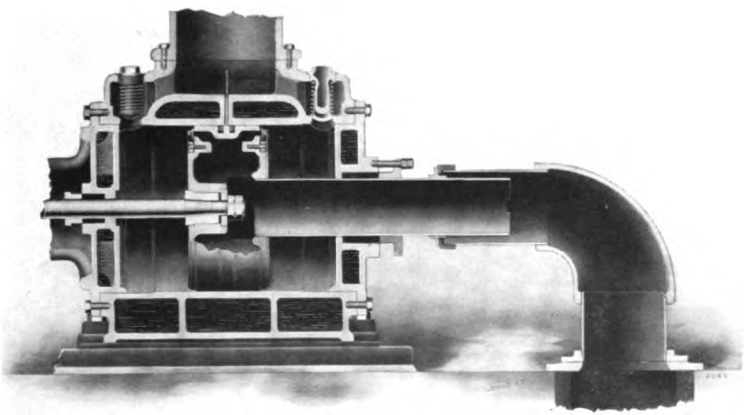
very light and the travel very short, there is no shock and practically no wear. When the valve moves it opens full, stays open for the full stroke and closes instantaneously. Nothing can be more simple and more positive than this valve action.



A "Hurricane-Inlet" Piston, with its Component Parts

The valve is free to turn around its guide ring and does actually turn in operation, never seating twice in succession in the same position and being thus automatically self-grinding. The removal of any discharge valve on the cylinder exposes the "Hurricane-Inlet" Valve, which can be turned around by hand and examined over its entire circumference without removing the cylinder head. There are only two moving parts, actuated solely by momentum and air pressure.

Reference to the illustration above shows the "Hurricane-Inlet" Valve around the piston rod, between the guide plate



Section of a "Hurricane-Inlet" Air Cylinder, with Cushioned Direct Lift Discharge Valves

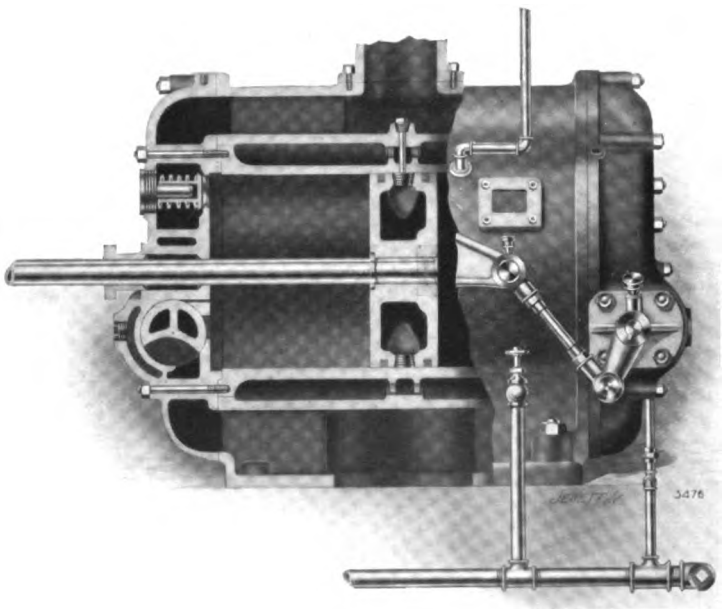
Digitized by Google

and the piston One of the segmental piston rings is in the foreground. Nothing about a compressor gives less trouble than the piston rings, which stay in place until worn out Yet the "Hurricane-Inlet" Valve, as shown in this illustration, is even more simple than a piston ring.

The intake area afforded by the "Hurricane-Inlet" Valve is 12 to 15 per cent of the total cylinder area. The construction admits cool air, the intake air entering through the inlet tube which is constantly cooled by contact with the jacketed cylinder head. The air piston and valves are cooled by continuous contact with the cold cylinder walls. The air is admitted in a solid column and everywhere encounters cool metal. Its temperature cannot be perceptibly raised in the fraction of a second required for a complete stroke.

The use of the "Hurricane-Inlet" Valve permits the most thorough cylinder jacketing possible, not only improving the compression efficiency but resulting in a sustained tightness of all working parts due to the better lubrication.

No valve gives a larger output of compressed air than the "Hurricane-Inlet." Compressors with "Hurricane-Inlet" Valves have an unusually large capacity per unit floor space



A "Rand-Corliss" Inlet Valve Cylinder, Half in Section, with "Imperial" Direct Lift Discharge Valves

Digitized by Google

because the construction permits a higher speed without undue loss than has generally been considered practical. This means more air admitted and compressed per minute, the high volumetric efficiency already mentioned being maintained at high speeds.

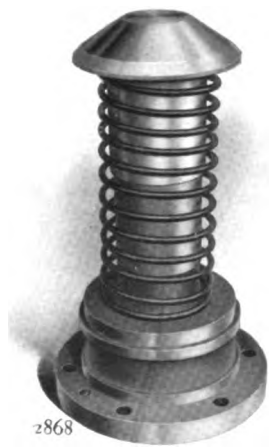
Rand-Corliss Inlet Valves

The Rand-Corliss Air Inlet Valve, used on certain "Rand" and "Ingersoll" types of Ingersoll-Rand Compressors, is the best application of the Corliss movement to air cylinders on the market. The valves themselves are of unusually large diameter and the working pressure is always distributed over the entire valve surface, which is almost precisely a half circle. This pressure, moreover, is always central, so that there is no tendency to wear either the edges of the valve or the surfaces with which they come in contact. Ample port opening is provided at the beginning of the stroke, full opening occurring when the piston is moving most rapidly and the correct timing of the closing of the valve ensuring a full cylinder of air. The construction provides short, free and direct passages for the entering air, with the minimum of clearance. The valve adjustments are so fixed that they cannot be deranged by an incompetent attendant, resulting in an incorrect valve movement and loss of efficiency. The construction of the valves, valve bonnets, stems, etc., is very strong; bearings are unusually liberal and lubrication is ample—all of these resulting in sustained tightness, minimum of friction and lowest maintenance cost. The large areas, short passages, correct movement, low clearance, and absence of leakage result in a very high volumetric efficiency.

Direct Lift Discharge Valves

The Ingersoll "Cushioned" Direct Lift Discharge Valve is standard on all but the smallest sizes of Ingersoll compressor types; and the "Imperial" Direct Lift Discharge Valve is used on the Rand line of Ingersoll-Rand Compressors. As they differ only in certain construction details, one description will suffice for both.

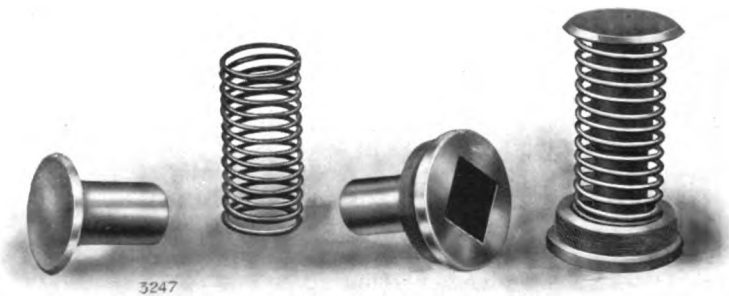
They are of balanced, positive, quick-closing type affording the maximum discharge efficiency. The valve proper is machined from selected steel, toughened in oil, annealed and ground to an accurate seat, the cross-section being properly reinforced at points of maximum stress. The projecting lip or rim just above the



A Complete "Cushioned" Direct Lift Discharge Valve

Digitized by Google

seat acts under the back-lash of the compressed air to assist the spring in closing the valve instantly and at the right time to prevent any return of the air compressed. The cap or valve guide is accurately ground to a wide and durable guide surface, ensuring that the valve shall return to its seat with precision and sustained tightness. The large diameter of the valve and its broad contact with the guide assure a uniform wear on valve and seat with no tendency to bind. The valve is free to turn and is therefore self grinding. The spiral spring is of the proper pitch and these valves are practically noiseless in operation. There are no webs, bridges or lips obstructing the port passage and the discharge area afforded is about 15 per cent. of the cylinder area. The construction renders entirely unnecessary any removable valve seats, all types of which have been tried out at some time in the Company's experience and abandoned for good reasons.



The Three Parts of an "Imperial" Direct Lift Discharge Valve, with a Complete Valve

Guarantees

The standing Guarantee of the Ingersoll-Rand Company is to make good at its works, by repair or replacement, any defect in the workmanship or material of its compressors which may develop within one year from date of shipment.

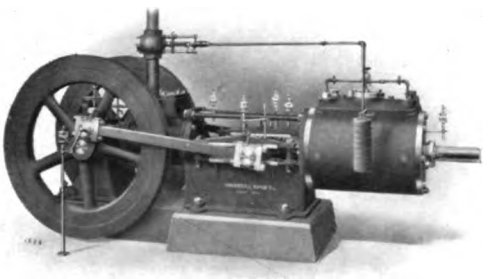
The Ingersoll-Rand Company furthermore furnishes its compressors under a standing guarantee of interchangeability of wearing parts.

The Ingersoll-Rand Company further guarantees that such is the care exercised in the selection of materials, in the workmanship applied, and in the methods of production, that its compressors, under fair treatment and reasonable freedom from abuse, will give better results, with the minimum of delay and expense for repairs, for a longer period than those of any other builder.

Digitized by Google

Standard Steam Driven Types

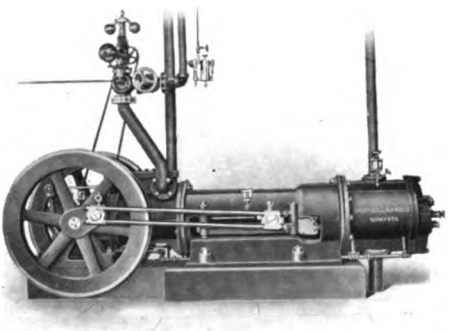
Ingersoll Class "F-1"



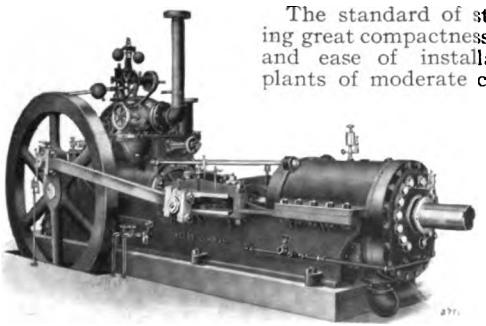
Small, compact compressors of straight line pattern, suitable for stationary or portable plants of small capacity: Simple steam cylinder with plain slide valve: Single stage air cylinder with complete water jacketing: Air valves of approved design and good economy: A type having a wide field where good "all-around" results and steady reliability are desirable: Pamphlet 3009.

Rand Class "RC-1"

Simple, plain, positive, straight line compressors of rugged design and good economy: Simple steam cylinder and single stage jacketed air cylinder: Suitable for plants of small or moderate capacity, semi-permanent or temporary in character, under conditions of hard service and ordinary unskilled attendance: Solid, compact, powerful and dependable machines, reasonable in fuel cost and maintenance: Pamphlet 3009.



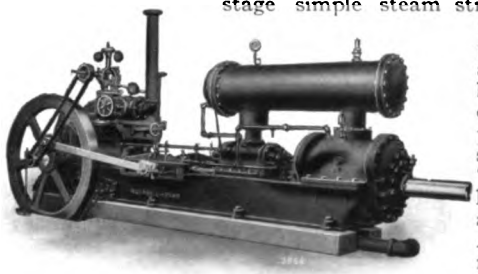
Ingersoll Class "A-1"



The standard of straight line types, embodying great compactness, moderate cost, simplicity, and ease of installation and operation: For plants of moderate capacity, hard service, ordinary care and semi-permanent character, for mines quarries and shops: Adjustable cut-off steam valves, except on smaller sizes which have plain slide valves: Single stage air cylinder with complete jacketing: Air valves of highest efficiency, giving strictly high-grade performance: Pamphlet 3002.

Digitized by Google

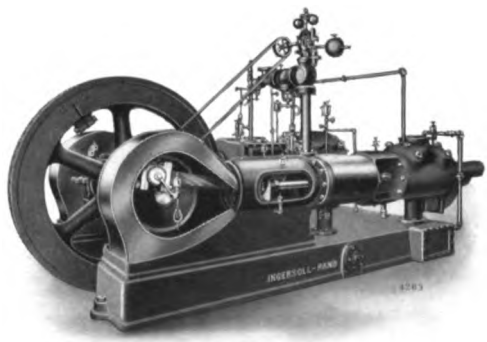
Ingersoll Class "AA-2"



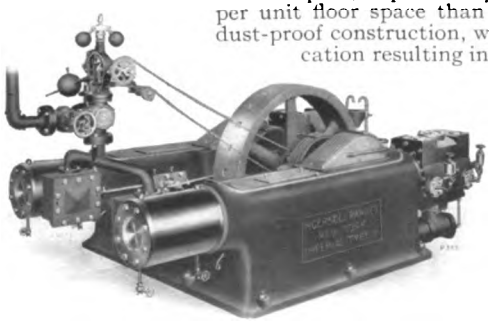
A development of the original "A" type into a two stage simple steam straight line compressor: Notable improvements in important details, making this a new standard of straight line economy, with all the efficiency of compound compression combined with the simplicity, compactness and "unit" quality of the straight line type: Balanced adjustable cut-off steam valves: Air cylinders and intercooler realizing the best two stage ideals: Pamphlet 3003.

Ingersoll Class "HH"

A powerful duplex machine, distinguished by its heavy subbase: Simple or compound, condensing or non-condensing steam cylinders, with Meyer valve gear; Air cylinders duplex or two stage, with complete jacketing and perfect intercooling: A solid, rugged, simple machine, high-class in every detail of design and construction: A "unit" construction, self-contained and automatic in operation; Deservedly one of the most popular types in every class of service: Pamphlet 3018.



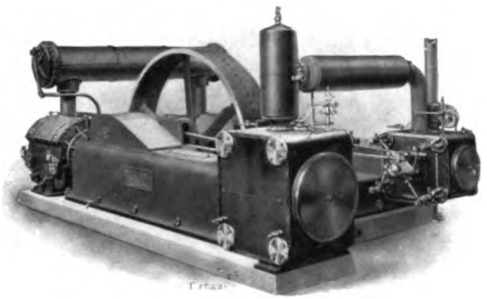
Rand "Imperial X"



A compact, duplex compressor with a larger capacity per unit floor space than any other type: Enclosed, dust-proof construction, with automatic "flood" lubrication resulting in the minimum of friction and wear: Steam and air cylinders simple duplex or cross-compound: Completely accessible and as easily installed and maintained as the simplest straight line type: A compressor of great staying power, automatic in operation: Preeminently the machine for hard, "knock-about" service: Pamphlet 3011.

Digitized by Google

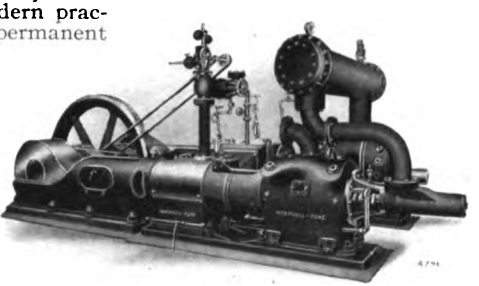
Rand "Imperial-Corliss"



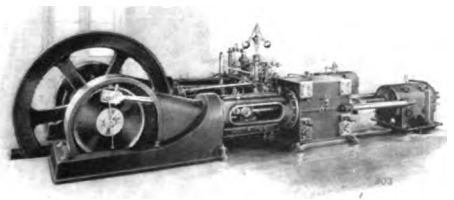
A development of the original "Imperial" type, to secure Corliss steam economy at high speeds: A high-duty machine in the best sense, with modified Corliss steam valves, Rand-Corliss air inlet valves and "Imperial" Direct Lift discharge valves: A superb type, newly designed throughout for high sustained economy at every point: Enclosed "flood" lubrication of every wearing part: A compressor always to be relied upon for high-grade results: Pamphlet 3013.

Ingersoll Class "O"

A duplex compressor new in every detail and representing the most modern practise: For semi-permanent or permanent plants of moderate or large capacity, where the best results are to be maintained: Enclosed, dust-proof construction, with a system of "flood" lubrication for every wearing surface: An unusually heavy, massive design throughout, intended for the very best performance under all conditions of operation: The latest embodiment of thirty-eight years of compressor building: Pamphlet 3006.



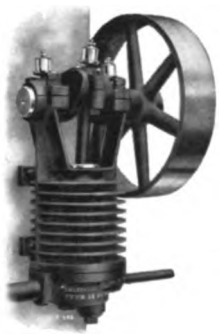
Ingersoll-Rand "Corliss"



A Corliss engine-driven compressor of the highest refinement of design, preeminent in its class for large permanent or semi-permanent plants where the highest attainable economy is essential: The machine which delivers compressed air at the minimum cost, combining the best steam engine and compressor practise, for results covering not months merely, but years of high-duty performance: Pamphlet 3005.

Digitized by Google

Standard Power Driven Types

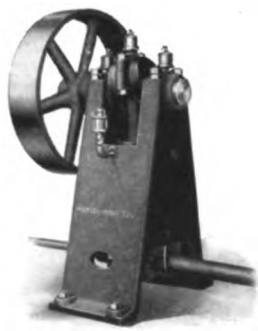


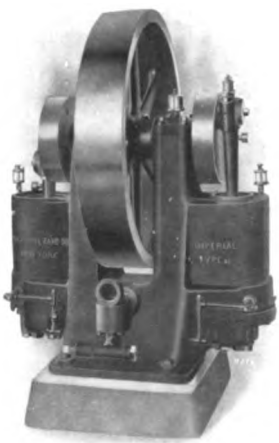
Rand "Imperial Baby"

A sturdy little machine representing the acme of simplicity: Single-acting, air-cooled cylinder, giving good economy at the moderate pressures and intermittent service for which this type is intended: Ordinarily built with a single belt wheel and bolted to a wall or post, but sometimes furnished with special frame for electric gear drive: Pamphlet 3010.

Rand "Imperial Junior"

A vertical, single-cylinder, single-acting compressor of the same capacity as the "Imperial Baby," but with a water-jacketed air cylinder: Built either with a subbase, with lugs for bolting to wall or post, or with a special frame for gear drive from a motor: A sturdy and efficient little machine for purposes where a limited capacity and ordinary pressure are required, with a steady demand: Pamphlet 3010.



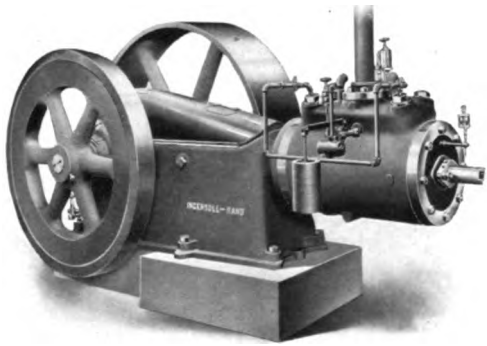


Rand "Imperial XI"

A duplex, vertical, single-acting machine, built for single or two stage compression: Water-jacketed air cylinders and air valves of correct design, giving good economy and steady reliability: A very compact design, requiring the minimum of floor space and accessible on every side: Especially adapted to shops, mills, foundries, factories and all installations of small capacity: A solid, powerful construction, with the minimum of parts and bearings, and a sturdy dependability: Pamphlet 3010.

Digitized by Google

Ingersoll Class "EE-1"



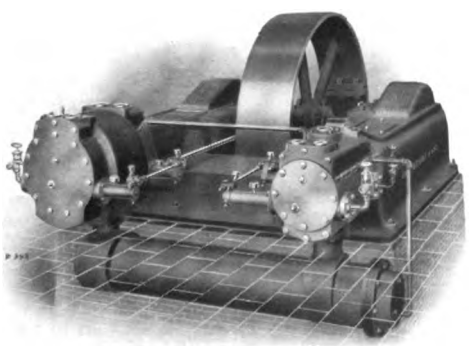
A straight line model representing the best design and construction applied to small machines: An enclosed construction excluding dirt and grit, with "splash" lubrication of every important bearing: Single stage air cylinder, with every provision for economical simple compression: Simple and compact, efficient and thoroughly well-built, adapted to a wide variety of uses: Suitable for small stationary or portable plants, driven from any source of power: Pamphlet 3010.

Ingersoll Class "JJ"

A modification of the "HH" steam-driven type for power drive, retaining the distinctive subbase and "unit" construction: Marked by extreme simplicity, heavy construction, powerful design, self-contained character, and a very high mechanical and compression efficiency: Adapted for driving from any prime mover, by any of the approved methods of connection: Air end duplex or two stage: A very popular type enjoying an increasing demand: Pamphlet 3019.



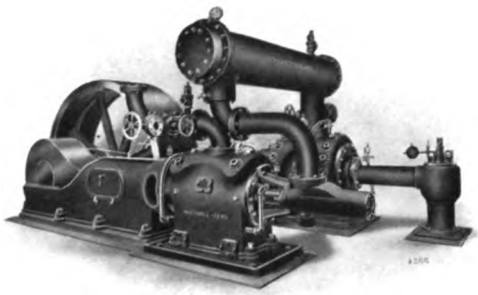
Rand "Imperial XB"



A power-driven machine with the characteristic features of the "Imperial X" pattern, with a heavy subbase and a central flywheel: Automatically self-regulating, with a "flood" system of lubrication throughout and an enclosed construction: A very large capacity combined with very small dimensions, adapting it to locations with limited floor space: A structure liberally designed throughout for the requirements of power drive from any source and by any method of connection: Pamphlet 3012.

Digitized by Google

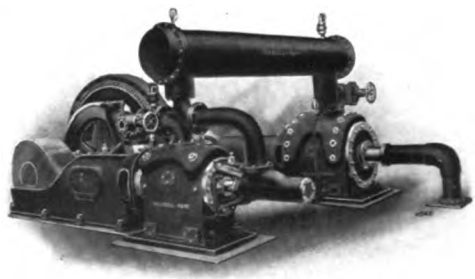
Ingersoll Class "PB"



A power driven modification of the Class "O" steam driven type, for belt or rope drive from an independent prime mover, with every refinement looking to economical compression: Cylinders completely jacketed, inter-cooler of unusual proportions, air valves designed for the best possible efficiency: Wearing parts protected from dust and dirt by the enclosed construction and automatically lubricated by a "flood" oiling system: Pamphlet 3007

Ingersoll Class "PE"

Another modified "O" type, exclusively intended for direct shaft drive by an electric motor, either direct or alternating current, induction or synchronous type: the "Corliss" of the power driven class, embodying every refinement for power drive at minimum operating cost: Special devices for starting and regulating, adapted to the high-class work for which the type is intended: A splendid machine of the most advanced construction: Pamphlet 3008.



High Pressure Compressors



Modifications of various types previously outlined, designed for pneumatic haulage, gas or air storage purposes, experimental use, etc.: As reliable, efficient, and thoroughly standardized for this exacting class of work as the machines for lower pressures: Characterized by notable improvements and distinctive devices which place them in the most advanced position: Pamphlet 3014.

Digitized by Google